

# **TRIAXES<sup>®</sup> STEREOMETER<sup>™</sup>**

**VERSION 3.5**

## **USER GUIDE**

Triaxes Ltd. Russia, Tomsk

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# 1. Introduction

## 1.1. Purpose

Triaxes StereoMeter is used to calculate the optimum stereo base for making stereo photos.

You may freely use Triaxes StereoMeter non-commercial purposes without time limitation. You may freely distribute Triaxes StereoMeter without modifying the installation package. You may not charge for the demo version of StereoMeter or distribute it as part of some other software product without written consent from Triaxes LLS.

## 1.2. Hardware and software requirements

IBM-compatible computer:

- CPU: Intel Pentium III or higher;
- RAM: 128 Mb;
- Free disk space: 15 Mb.

Operation system:

- Microsoft Windows XP;
- Microsoft Windows Vista.

## 1.3. Technical support

Technical support is not guaranteed for free version of Triaxes StereoMeter.

However, if it was purchased within Triaxes 3DMasterKit software package, to get technical support, please contact the distributor you purchased StereoMeter from. Besides, you can ask your questions by sending an e-mail message to [support@triaxes.com](mailto:support@triaxes.com). Please, specify your activation user name and program edition, while contacting Triaxes Technical support group.

Welcome to our web-site: <http://www.triaxes.com>.

This site contains news about Triaxes 3DMasterKit software package and here you can download updates for the programs. Besides, the site contains useful articles dealing with theoretical issues about stereo, lenticular technology and using 3DMasterKit. The site also contains information about distributors and has useful links: a gallery, a forum, where you can discuss anything with authors and other users of the program and answers to frequently asked questions (FAQ).

## 2. Theory

### 2.1. Stereo Base

**Stereo base** - the distance between left and right shot angles or between leftmost and rightmost frames in multi-frame series.

The size of stereo base plays the key role in the of stereo photo creation. If you make stereo photos of scenes that are up to 3-5 meters away, it is quite enough to use the base of 65-70 mm, i.e. approximately the distance between human eyes. When the distance to the objects being shot increases, stereo base should also be increased in order to get good stereo effect. You can use the following formula to calculate approximate stereo base:

$$B=0.03*D,$$

where **B** is stereo base and **D** is the distance to the closest object in a scene being shot.

The coefficient of 0.03 is used due to the angle of sight line convergence (approximately 1-2°) that provides optimal conditions for watching stereo effect.

For exact calculation of the stereo you need to define the relative position of objects in the scene, method of taking a stereo photo, camera parameters and being planned conditions of viewing finished stereo photo.

StereoMeter takes into account all these parameters when calculating and could recommend the best position of objects in the scene and the optimal stereo base to obtain good stereo effect.

### 2.2. Methods of taking stereo photos

The idea of all methods of taking stereo photos is to get a pair of frames or a sequence of frames with parallax.

**Parallax** - the shift of the object you are looking at caused by changing the viewing angle.

There are two methods of taking stereo photo: parallel and directional. When the parallel method is used, direction of optic axis of a camera lens does not change (Fig.1, a), but when the directional method is used, optic axis of a lens is turned so that it is always directed at the central object of a scene (Fig. 1, b). The directional method models the convergence of human eyes.

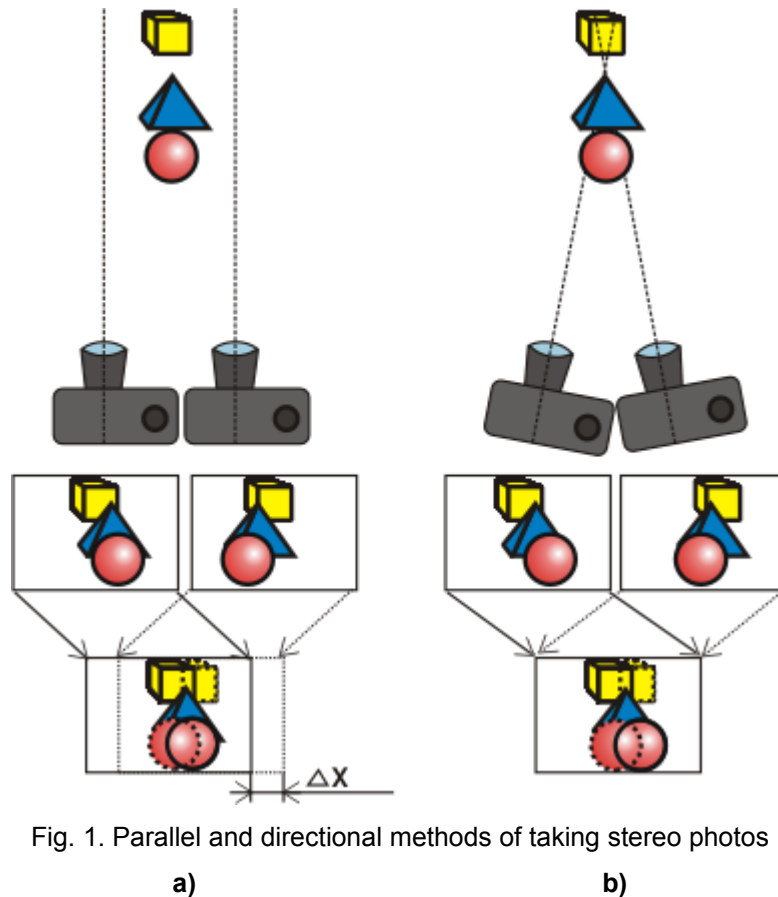


Fig. 1. Parallel and directional methods of taking stereo photos

a)

b)

The advantage of the parallel method is in its simplicity – there is no need to turn a camera. The disadvantage of this method is that it is necessary to process photos additionally (compensational shift). Compensational shift means moving photos relatively to each other so that to get zero parallax (no doubling) for one of the objects in the composition (zero parallax object). This process models convergence of eyes after a stereo pair is taken. When you view a stereo image, zero parallax objects will be perceived as located on the key plane; objects located closer to the photographer in real life will have negative parallax and seem as if in front of the zero parallax object; objects located in real life farther than the zero parallax object will have positive parallax and will be perceived as if they are in the background of image. In Fig. 1, you can see a compensational shift ( $\Delta X$  is the size of the compensational shift) where the stereo pair is aligned by the blue pyramid - this object has zero parallax.

After the shift is done, the horizontal size of the images get smaller - the stereo pair includes only those parts of the images that are aligned in the initial images. Actually, it is possible not to make the compensational shift. In this case, all objects on the scene will have negative parallax and seem as if they are in front of the plane the image is printed on. In this case, only "infinitely distant" objects will have zero parallax.

With the directional method, it is all vice versa, the process of taking photos becomes more complicated (you have to turn the camera), but the images you get - are already a stereo pair and if you took them without inaccuracies, you may need no additional processing.

The directional method sometimes allows you to get a stereo image that reproduces natural perception more accurately. But the difficulty of this method is that the parallax of distant objects could be too large. It may reduce the comfort while viewing the stereo image. One more disadvantage of the directional method is a possibility of appearing different-angle affine distortions which may introduce some dissonance in the being viewed image. That is why this method is used to take photos under ad hoc conditions.

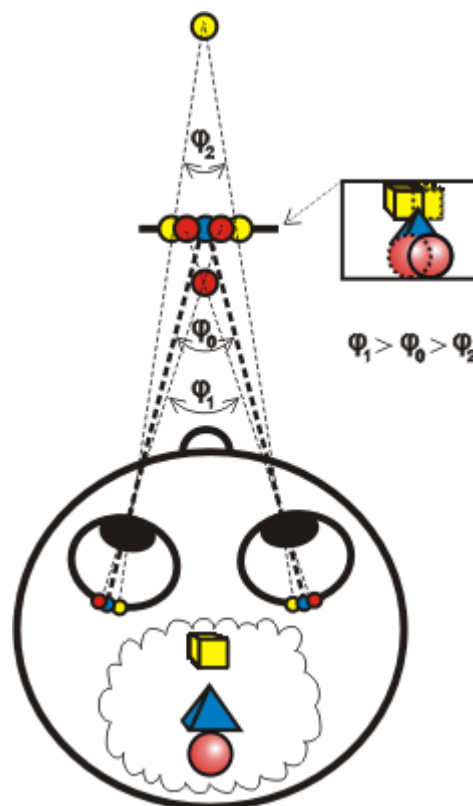
Due to its simplicity and the stability of its results, the parallel method is used more often. And computer processing makes creating a compensational shift an easy task.

## 2.3. Stereo Perception Scheme

### 1.1. Stereo Perception Scheme

When you are looking at a stereo picture, the following happens: (Fig. 2):

- objects with zero parallax are seen with the convergence angle  $\varphi_0$  and perceived as located on the key plane (the blue dot in the picture);
- objects having positive parallax in the image (red dots) are seen with the convergence angle  $\varphi_1$  and perceived as located in front of the key plane;
- objects with negative parallax (yellow dots) are seen with the convergence angle  $\varphi_2$  and perceived as located behind the key plane.



**Fig. 2.** Three-dimensional image reconstruction

The nature of this phenomena lies in the ability of the eye-brain system to process information within some range  $\Delta\varphi$  ( $\Delta\varphi=\varphi_1-\varphi_2$ ) of the convergence angle and merge conjugated images into one three-dimensional image. The maximum  $\Delta\varphi$  range is several degrees. If the parallax of the images in a stereo photo exceeds abilities of the brain to merge images, it becomes less comfortable to view such image and you can see it double. That is why it is important to choose stereo base correctly when you take stereo photos.

### 3. Using StereoMeter

#### 3.1. StereoMeter Interface

StereoMeter allows you to take into account a lot of parameters and choose the optimum stereo base size. The program interface is shown in Fig. 3.

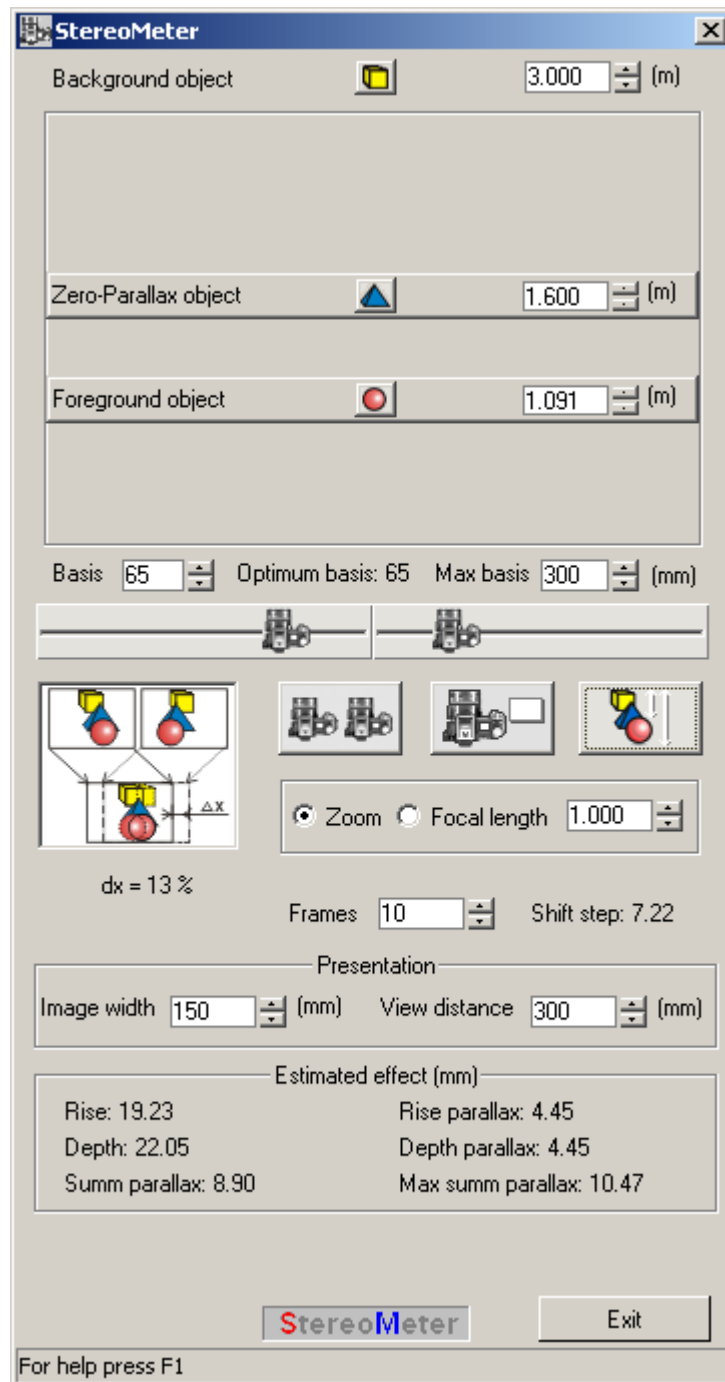




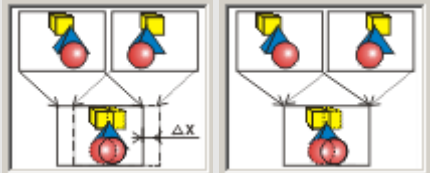

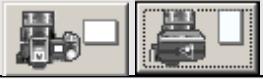


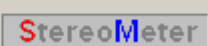


Fig. 3. StereoMeter Interface

The table below contains control elements description and it's functionality.

Table 1. StereoMeter Control Elements Description

Control Element	Function
<b>Input field of background objects distance</b> Background object  3.000 (m)	Inputs a numeral value with keyboard or with count box arrows.
<b>Input field of zero-parallax objects distance</b> Zero-Parallax object  1.600 (m)	Inputs a numeral value with keyboard or with count box arrows. To specify the object distance you need to capture this element with the left-mouse button and drag it to a new position. To capture you need click the left-mouse button on the element at any place (except input field).
<b>Input field of foreground objects distance</b> Foreground object  1.091 (m)	Inputs a numeral value with keyboard or with count box arrows. To specify the object distance you need capture this element with the left-mouse button and drag it to a new position.
<b>Current base value</b> Basis 65	Displays the current base size. Inputs a numeral value with keyboard or with count box arrows.
<b>Output field of optimum (recommended) base value</b> Optimum basis: 65	Displays the recommended base size. This size is specified with the objects position in the scene and other parameters.
<b>Input field of the maximum base value</b> Max basis 300 (mm)	Specifies the maximum base size. Within this interval the base size can be changed.
<b>Base size of taking a stereo photo</b> 	Specifies the base size of taking a stereo photo. This size will be used for evaluation of the expected stereo effect characteristics. To specify the necessary size of the stereo base, move the mouse pointer to one of the sliders with the image of a camera on it, capture it with the left mouse button and drag it to the necessary position.
<b>Images combination ways</b> 	Displays the way which will be combine images at different methods of taking stereo photos.
<b>Switching the methods of taking a stereo photo</b> 	Selects the method of taking a stereo photo: the parallel or directional by clicking the corresponding button. At the left is the button of parallel mode, at the right – the button of directional mode.
<b>Selecting the camera orientation</b> 	Selects the camera orientation (album/portrait) by clicking the corresponding button.
<b>Automatic calculation of scene object positions</b> 	Clicks this button to move the foreground object and zero-parallax object to optimum distance with specified base size.
<b>Input field of objective parameters</b> <input checked="" type="radio"/> Zoom <input type="radio"/> Focal length 1.000	Inputs the focal distance or zoom to specify the optical characteristics of camera objective.
<b>Input field of frame sequence number. The camera shift step is displayed in the next field.</b>	Specifies the frame sequence number. The camera shift step at specified base size is displayed In the next field.

Control Element	Function
Frames <input type="text" value="10"/> Shift step: 7.22	
<b>Horizontal size and preview conditions of final stereo photo</b> Presentation Image width <input type="text" value="150"/> (mm) View distance <input type="text" value="300"/> (mm)	Specifies the supposed width and distance for the final stereo photo pre-viewing.
<b>Output informational field</b> Estimated effect (mm) Rise: 19.23 Rise parallax: 4.45 Depth: 22.05 Depth parallax: 4.45 Summ parallax: 8.90 Max summ parallax: 10.47	Outputs the final stereo photo characteristics.
<b>Output informational field</b>  Basis is too large for current presentation conditions 	Outputs the warning messages.
<b>Exit button</b> <input type="button" value="Exit"/>	Ends work with the program.
<b>Status bar</b> <input type="text" value="On the stereophoto this object will be 'hover' above"/>	Opens context help

### 3.2. Work with StereoMeter

We can suggest two ways of working with StereoMeter. The first way assumes that the size of stereo base is fixed. The second method uses changeable stereo base.

For instance, stereo shooting is executed with the Triaxes® 3D Rail M1-30 tripod adapter. (Fig. 4).



Fig. 4. Taking a stereo photo using Triaxes® 3D Rail M1-30 tripod adapter

The tripod adapter has the following characteristics:

- Distance between camera adapter-platforms is 22 cm.
- Stereo base changed up to 30 cm by stereo shooting with one camera.
- Stereo base changed up to 56 cm by stereo shooting with two cameras.

### **Fixed base**

The 3D Rail M1-30 tripod adapter has fixed distance between camera adapter-platforms which equals 22 cm. We can make a stereo pair by putting two cameras on these platforms and using Triaxes® 3D Camera Control for synchronous remote release. We are going to use StereoMeter to calculate the optimum distance to the scene objects. Do the following actions which specified with numbers in [Ошибка: источник перекрестной ссылки не найден 5](#):

- 1) Set the maximum base size (for 3D Rail M1-30 model it equals 300 mm).
- 2) Set the base which will be used: 220 mm.
- 3) Set the background object distance (let it be 25 meters).
- 4) Set the focal objective distance: 50 mm.
- 5) Set the horizontal camera orientation.
- 6) Set the parallel method of taking a photo.
- 7) Click the automatic object positions button.

As a result, StereoMeter will calculate the optimum distances to the foreground objects and to the zero parallax objects. Corresponding control elements (in [Ошибка: источник перекрестной ссылки не найден5](#) are specified by 8 number) will be moved to the proper position. It means that optimum stereo effect in specified shooting conditions will be reached when foreground objects distance is about 4-5 meters and zero-parallax objects distance is about 7-8 meters.

Distance values are taken to the third sign. It is specially made for macro stereo shooting when working with short distances. However, by shooting objects in usual conditions it is not necessary to keep all distance within one millimeter. The program simply shows what distances approximately would it be. Stereo pair was taken in similar conditions and it is shown in Fig. 6. Photographer had no possibility to move carriage, but distance to the object was chosen about 5 meters that allowed the good stereo photo to be taken.

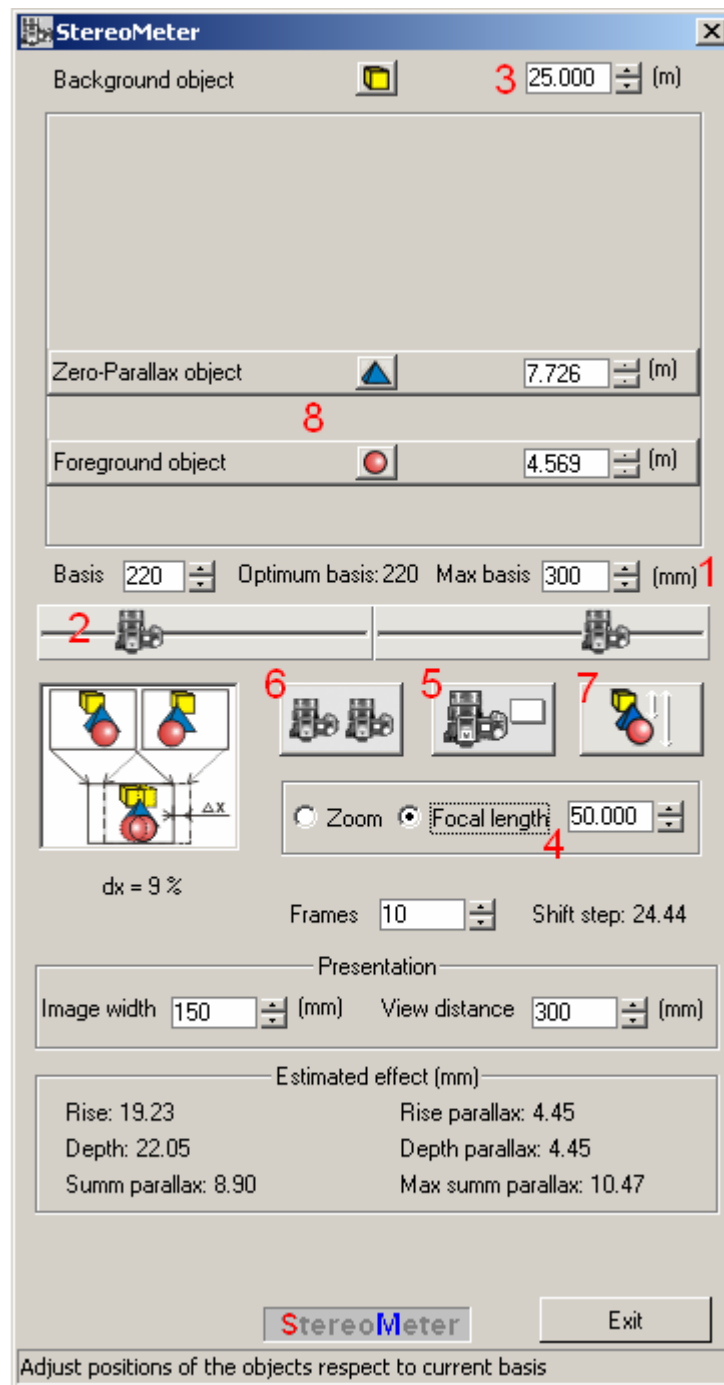


Fig. 5. Object distances calculation by fixed base



Fig. 6. Stereo pair. Stereo base is 22 cm. Author of the photo is Polyakov A. Photo is made in 3DMasterKit

### Changeable base

The case of multi-frame shooting is described below. Let's take a photo of the flower (Fig. 7)



Fig. 7. Objects' location in multi-frame shooting of a flower.

Distance to the flower is about 40 cm. Focal objective distance is 55 mm. It is difficult to define distance to the background object because flower grows among grass and it is not clear which object to select. So let it be the distance about 50 cm to zero-parallax object, and distance to background object is 70 cm. We plan to take 12 shots. Set this value in StereoMeter (Fig. 8).

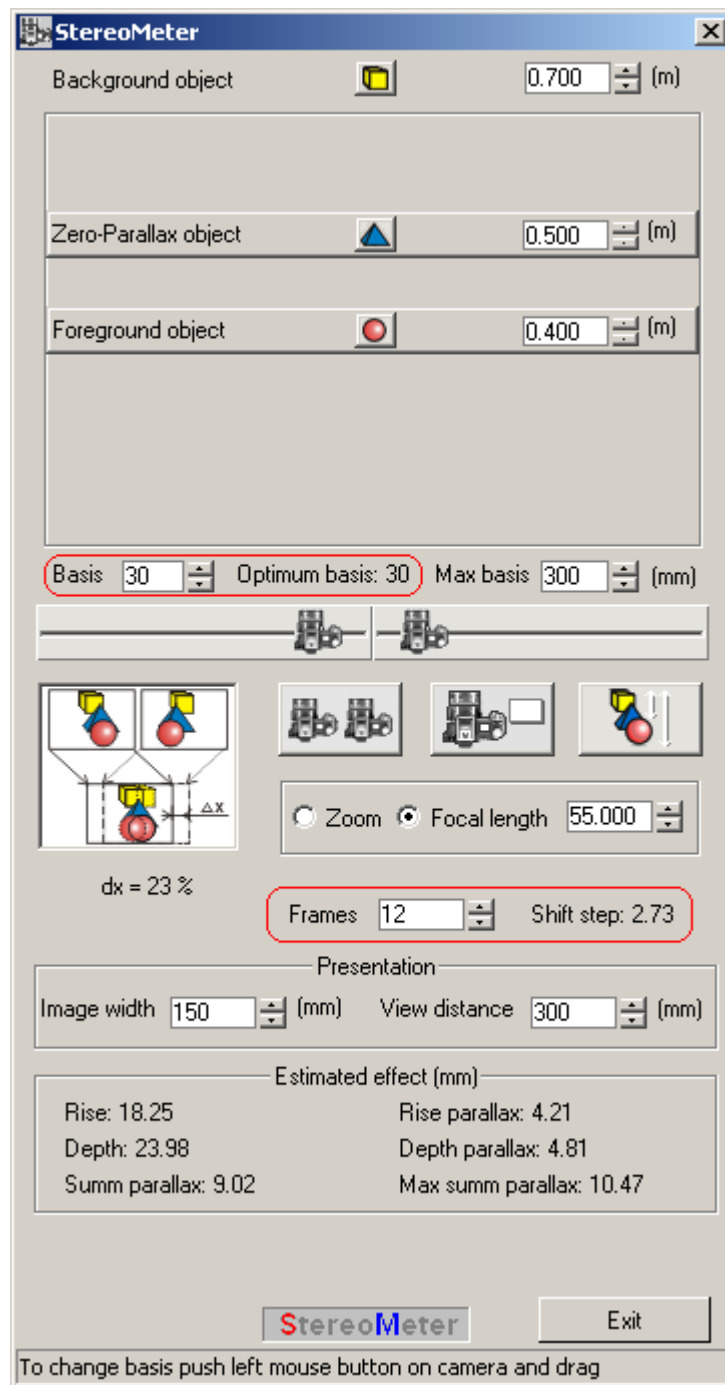


Fig. 8. Stereo base calculation

The program recommends using stereo base of 30 mm (Optimum basis output field) and shift step is about 3 mm. The base of multi-frame sequence is the distance between shooting points of the leftmost and rightmost sequence frames. Make a multi-frame series by following StereoMeter instructions. Shooting begins from the leftmost camera position and moving it by 3 mm step after every shot, make 12 shots. Shooting is shown in Fig. 9. The resulting frame series is shown in Fig. 10.



Fig. 2. Multi-frame shooting with one camera (the leftmost and the rightmost positions are shown)

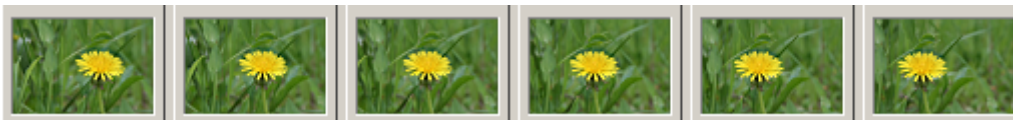


Fig. 10. Multi-frame sequence (not all frames are shown)

Multi-frame shooting even if using one camera is recommended to execute with Triaxes® 3D Camera Control remote release because it defends camera from shaking by clicking release button.

Evidently, that in usual conditions there is not always a possibility to calculate the shooting parameters. However, after some practice you will understand which base should be chosen in most of situations. Besides, you can write the parameters of frequent shooting scenes in your special book to remember well. Also it is recommended to make duplicate series. For instance: at the first series shot with calculated base, at the second decrease on 25%, at the third – increase on 25%. As a result you will have some choice to select the best variant.


Sequence of frames is used for making lenticular stereo photo. Any frame pair of sequence will be stereo pair which can be used for making cards for stereoscope (Fig. 11) or anaglyph image (Fig. 12) (anaglyph glasses  are necessary to see 3D).



Fig. 11. Stereo pair from multi-frame sequence made in Triaxes 3DMasterKit



Fig. 12. Anaglyph stereo photo is made in Triaxes 3DMasterKit

The current version of Triaxes 3DMasterKit is available on [www.triaxes.com](http://www.triaxes.com).